The Multi-Donor Trust Fund for Sustainable Logistics (MDTF–SL) commissioned a series of short notes from recognized thought leaders to better understand burgeoning issues within the MDTF–SL’s thematic pillars. This note explores issues within the Agro-Logistics thematic pillar and was prepared by Prof. Jack van der Vorst and Dr. Joost Snels from Wageningen University, The Netherlands.

The Agro-Logistics pillar is one of three focus areas, or thematic pillars, for the MDTF–SL. Activities falling under this pillar fall within an overall development objective strengthen food security programs and improve the competitiveness of agricultural exports by developing countries by sustainably reducing logistics costs, and expanding market access for rural producers.

The MDTF–SL will pursue this development objective by financing studies, methodologies and tools that assist governments, agricultural producers, distributors and other private agents to increase the efficiency of supply chains, improve the traceability and profitability of "green goods" and reduce food waste and other logistics costs.

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1 The World Bank MDTF–SL staff recognizes the valuable contribution of Patrick Labaste during the review of this paper.
Developments and Needs for Sustainable Agro-Logistics in Developing Countries

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The Multi-Donor Trust Fund for Sustainable Logistics (MDTF-SL) aims at promoting innovative assistance projects that can break new grounds, test new ideas, and generate new knowledge for sustainable logistics that can be replicated in other countries and project. In November 2013 we were asked to write a position paper that analyses the state of affairs in Agro-Logistics. It aims to (1) review and suggest a conceptual grounding for the MDTF-SL’s activities; (2) outline the specific challenges developing countries face on Agro-Logistics; and (3) review existing attempts or interventions to meet the identified challenges.

This position note starts with a definition for Agro-Logistics to have a mutual understanding of the concept. Section 2 presents emerging global trends and developments, which are then translated to key logistics objectives in section 3. Next, in section 4, five international cases are presented that illustrate the needs and key bottlenecks in agro-logistics for developing countries. Section 5 presents an overview of potential interventions to improve logistics performances, resulting in recommendations (section 6).

1. What is Agro-Logistics?

Historically, logistics has been considered an issue deserving modest priority in each organization; it was merely regarded as a cost component. Nowadays (especially in the developed world), logistics is seen as a value-adding process that directly supports the primary goal of the organization, which is to be competitive in terms of a high level of customer service, competitive price and quality, in terms of compliance with rules and regulations, in terms of being able to satisfy extensive qualitative service and information requirements imposed by consumers and other stakeholders of the supply chain and finally in terms of flexibility in responding to market demands.

Logistics management is defined by the Council of Supply Chain Management (SCM) Professionals as follows: ‘Logistics is that part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements (Lambert et al., 1998) and satisfies the requirements imposed by other stakeholders such as the government (new rules and regulations such as the General Food Law) and the retail community (e.g. Global Food Safety Initiative)’. Included within this
This first three sections of this paper are partly based on literal text excerpts taken from Van der Vorst et al. (2007), Van der Vorst (2012) and Soysal et al. (2012) respectively.
definition are logistics decisions related to network design (e.g. plant site selection), sourcing, order fulfillment (including demand forecasting), transportation management, inventory management, materials handling, and return goods handling. In addition aspects of product development such as designing packaging variants of products and associated product labels are also important. Key to optimal decision making is information management, that is gathering relevant data in the chain using all kinds of technological and information systems and distributing this data to chain participants so it can be used in business intelligence applications. In the definition a supply chain refers to a series of (physical and decision making) activities connected by material and information flows and associated flows of money and property rights that cross organizational boundaries (Van der Vorst, 2000). The supply chain not only includes the manufacturer and its suppliers, but also (depending on the logistics flows) transporters, warehouses, retailers, service organizations and consumers themselves (Chopra and Meindl, 2012).

Agro-Logistics can be seen as a sub-discipline of Logistics. An agro-food supply chain comprises organizations that are responsible for the production (farmers), processing (industry) and distribution (service providers and traders) of vegetable or animal-based products. Agro-Logistics manages the logistics of three main product types:

1. Supply chain for agricultural commodities (such as cacao, grain, soy, sugar, coffee). In these foremost international supply chains agricultural products are traded and exchanged in the open market place, in the end to be foremost used as raw materials for industrial producers for processed food products. A key trend in these chains is the search for de-commoditizing of goods and the development of dedicated supply chains that fulfill specific requirements (e.g. fair trade coffee).

2. Supply chains for highly perishable agricultural products (such as fresh vegetables, flowers, fruit, fish, potatoes). In general, these chains may comprise growers, middlemen, auctions, wholesalers, importers and exporters, retailers and specialty shops and their input and service suppliers. Basically, all of these stages leave the intrinsic characteristics of the perishable product grown or produced in the countryside untouched, although actors try to exploit these as much as possible (for example, ready to eat products and processed smoothies). The main processes are the handling, conditioned storage, packing, transportation, and especially trading of these goods. A key trend is the increase of partnerships between international actors resulting in long-term contracts, in order to deliver the complete assortment year-round.

3. Supply chains for high-value, processed and customized products (such as processed dairy or meat products). These chains produce goods for the higher end of the market, and are mainly characterized by closed relationships between international suppliers and retailers with agree upon contracts for a longer term.

Agro-Logistics concerns all activities in the supply chain to match product supply from the farm with market demand for those products. It aims at getting the right agro-product, at the right place, at the right time, according to the right specifications (including quality and sustainability requirements) at the lowest cost. Actors in these types of chains understand that original good quality products might be subject to quality decay because of an inconsiderate action of another actor, for example storing a unit load of milk on a dockside in the burning sun.
2. Megatrends and developments

Not long ago agricultural produce was transported to the local marketplace by the farmer. Nowadays products are flown all over the world to provide products to demanding consumers (foremost) in developed countries. For example, haricot verts arrive in the Netherlands by air from Africa, bananas are delivered in refrigerated containers by sea from Central America, and palm oil seeds arrive by bulk carriers from Asia. Flowers that pass through the Dutch flower auctions in the morning will be on sale that same evening in New York and bought by customers in Tokyo the next morning (Network Agrologistics, 2011). It is clear that significant changes have taken place in the last 25 years, but also that more changes are about to happen. Table 1 presents an overview of megatrends that will impact Agro-logistics to a large extend.

The first megatrend concerns demographic and welfare developments. It is expected that the worldwide population will further increase, foremost in the BRIC countries, Africa and Asia, and peak at 9-10 billion people in 2050. The population in Africa will double (adding 1 billion), the population in Asia will also increase by 1 billion persons. In search for labor two-thirds of the world population will live in urban areas in 2050. There is a rising middle class: in emerging economies: up to 3 billion in next 20 years, with a change in lifestyle and diet patterns. As a result, world food prices may rise 30-50% in the coming decades, which leads to the question of affordability of good food for people in developing and emerging countries. This will not only put pressure on the food system regarding the availability and accessibility of food in these cities, but it also emphasizes that the labor force in the rural areas will decrease putting even more pressure on the food system. In contrast, one out of three European regions will have to deal with a declining population.

The second megatrend relates to the overall societal focus on sustainability, to preserve the environment and material availability for the next generations and to provide fair working conditions worldwide. Due to the growing population and overall welfare, demand will increase for high value food, feed, fuel and fibre. Also the pressure on vulnerable eco-systems further increases, next to already present issues as erosion, pollution, and depletion of natural resources. Climate change will increase fluctuations and dynamism in weather conditions, which will further decrease the stability of food and feed availability. This has resulted in significant price increases in the last five years for staple foods such as sugar, cacao and coffee (FAO food price index, 2014). Furthermore, it will influence the production areas suitable for food production.

The third megatrend concerns advanced process automation, information and virtualisation. Examples are the increased use of intelligent robots (think of the modern greenhouses that are setup worldwide), the use of conditioned reefer containers for international transport and the use of smartphones increasing information availability and transparency in the supply chain (for example, smartphone usage has nearly doubled in 2013 in the Middle East and Africa). This changes the way people do business and improves opportunities for organising and managing global cold chains. This trend is increased by the significant investments Western companies are doing in developing countries (FAO, 2012).
The last megatrend is globalisation and related economies of scale. Nowadays, food products are sent around the world to provide year-round availability of goods. On the other hand, more and more countries are trying to secure food availability in their own country by setting up integrated agroparks.

Table 1. Megatrends and impact on AgriFood chains (Van der Vorst, 2012).

<table>
<thead>
<tr>
<th>Megatrend</th>
<th>Overall impact on AgriFood supply chains</th>
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</table>
| 1. Demographic trends: | • Increase in demand for food, especially in BRIC countries to 2050 (approx. 65%) - also increase in value-added products such as meat, fish and dairy products. European markets stabilize. The aging population increases demand for more value-added products, safe and healthy food.  
 • Decline potential labour force.  
 • Increase in land, materials and energy use, resulting in scarcity of natural resources and increasing focus on sustainability  
 • Increase in waste production and flows fertilizers, packaging materials, industrial waste streams)  
 • Increase in global flows (for emerging markets) but also more local production, more people need to be fed while the space to grow food is smaller.  
 • Increase product range by multiculturalism  
 • Increase in shareholders’ interests first set in society; less operating from a collective interest  
 • Increased demand for convenience products  
 • Increase in complexity regarding food, where to produce fresh food and how to get it in the right way in the metropolis? |
| population increase of 7 to 9 billion people in 2050 - especially in Asia, Africa and Latin America (growing BRIC countries) which will consume more high value products due to rising prosperity;  
 urbanization (in 2050 70% of the population lives in one of the many mega poles);  
 multicultural cities due to emigration / immigration  
 decline in population in the Netherlands and Western Europe.  
 individualisation | |
| 2. Climate change and overall societal focus on sustainability | • Companies require a license to operate! Government will focus on more stringent environmental requirements to combat climate change.  
 • Worldwide, only 150 crops widely grown and eaten at large scale. Twelve of them provide three-quarters of the world's food, three (rice, wheat and maize) half of the vegetable food energy. Less biodiversity (fewer species and varieties) not only means less variation, but also more vulnerable to diseases and pests, and more risk of epidemics.  
 • Increase price volatility of raw materials. |
| 3. Further process automation, computerization and virtualization (doing business via the Internet) | • Increased automation and computerization level, allowing comprehensive real-time information exchange and dynamic (central) planning and control of activities in supply chain networks. This also requires more staff training.  
 • Increased standardization of IT systems and data sources, as well as containerization allows virtual business making possible, resulting in global sourcing and distribution via long complex chains.  
 • Increased ability to register and store the history of a product throughout the chain and communicate it to consumers through smart tags.  
 • Increasing decoupling of goods and information flows, thus increasing internationalization of production |
| 4. Further internationalization versus localization / regionalization | • A decreasing number of big (international) companies in every link of the chain dominates the market, as "elephants dance with elephants" (big companies do business with other large companies).  
 • Increased outsourcing as companies focus on their core business and due to fragmentation of production processes (e.g. tires from china, steering from brazil, mounting the bicycle in NL).  
 • Increased focus on sustainability also leads to regionalization, buying products from the region preferably produced on a small scale and close to nature.  
 • Specialization requires skilled labour |

It is clear that these developments have very important consequences and impacts on performance requirements of the agro-logistics systems and businesses in developing countries. The next section will discuss such requirements and implications.
3. Logistics performance requirements and key logistics issues

When analyzing the megatrends one of the main concerns is food security, regarding the availability of food in different parts of the world. Food security is defined as existing “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life” (World Food Summit of 1996). It requires the increase of (higher value added) food production on the one hand, and reduction of food losses in the supply chain on the other.

The megatrends have consequences for the sourcing, processing and distribution of agroproducts. Last decades a lot of Dutch farmers have transferred their business to Africa, Eastern Europe or Asia. The same is happening worldwide – due to risk management and climate change as well as economic developments. More and more commodities and standardised products are produced in low-income countries, whereas products for the high end of the market remain (for now) in such Western countries. By spreading production or sourcing worldwide chances are reduced the business is affected by extreme weather conditions.

Due to food related diseases (e.g. EHEC, BSE) and globalization of food production (Nepstad et al., 2006), consumers (especially in the Western world) have become more aware of the origin and nutritional content of their food. This leads to a growing interest in traceability, freshness and quality of products. At the same time, producers expand product assortments to satisfy consumer’s broadening desires. This results in more complicated production and distribution processes and increased transportation costs.

The need for food security, changing production locations and the request for high quality, value added products worldwide increase the need for global goods flows. Technological developments such as containerization enable new ways of transportation (see for air, rail for truck), but also enable transport over larger distances. On the other hand, the need for resource efficiency and sustainable products requires logistics practices that take societal and environmental performance indicators into account next to the traditional economic indicators. Urbanization requires advanced logistics concepts that are able to provide food products in megacity centers. Increasing uncertainty in food harvests and consumption and related price fluctuations may result in potential stock formations in the chain – but where these inventories will be located is not clear. Availability of services is often a major constraint, especially with specialized services for cold chain, an important factor in the overall quality and costs of the value chain. However the refrigerants used are also one of the largest concerns to climate change.

It is clear that next to the traditional logistics management objectives, such as cost reduction and responsiveness improvement, sustainable agro-logistics management requires a different management approach that also considers intrinsic characteristics of food products and processes (c.f. Van der Vorst et al.; 2011) next to sustainability considerations (Seuring and Muller, 2008; Ahumada and Villalobos, 2009; Soysal et al., 2012). In the remainder of this section, we discuss the key logistical aims in sustainable agro-logistics management in three groups: (1) cost reduction and improved responsiveness, (2) improved food quality and reduction of food waste, and (3) improved sustainability and traceability. We also discuss the key logistical issues that need to be considered to adequately manage the related key objective.
2.1. Cost reduction and improved responsiveness

Cost reduction and responsiveness improvement are the two main traditional performance objectives in logistics management. Cost refers to the total global network costs from the source of supply to its final point of consumption. The recent economic crises and ongoing globalization have boosted the importance of achieving lowest cost in almost all supply chains. Unlike the past, food industries are heading towards international markets for sourcing necessary products for their operations. Additionally, global coordination and optimization of geographically dispersed facilities is necessary (Brown et al., 2001) to quickly and accurately determine the distribution options and costs (Chopra, 2003; Simchi-Levi et al., 2009). Responsiveness has two main dimensions: the time between placing and receiving an order, and how quickly companies respond to the dynamics of the global marketplace such as customer’s unique and rapidly changing needs, new product introductions and new sourcing opportunities (Beamon, 1998; Fisher, 1997). Responsiveness and flexibility are key issues to maintain customer satisfaction in the food industry (Lambert and Cooper, 2000). Nowadays Western consumers ask for more product variety and high frequent deliveries with short lead times that forces fast production in small batches. Also, demand uncertainty has increased due to increased product variety and competition. Gunasekaran et al. (2008) state that the key factors for forming a responsive supply chain are: timely information sharing, shortening the total cycle time, coordinating the workflow, implementing good decision support systems, reducing lead times, integrating information about operations, reducing redundant echelons and creating flexible capacity. In parallel, new ICT tools that facilitate more advanced information exchange (Cachon and Fisher, 2000) and collaboration (Christopher and Juttner, 2000) help companies to improve their responsiveness. Companies are also confronted with trade-offs between the cost of the SC (efficiency) and its responsiveness, resulting in discussions on the position of inventories and the customer order decoupling point (Van der Vorst et al., 2005; Van Donk, 2001). On one hand, increased product diversity and competition leads to a make to order production system with a decrease in inventories to reduce inventory costs; on the other hand producing to stock and keeping more inventory (buffer/safety) in the chain guarantees quick customer response. Therefore, agro supply chains have the challenge to maintain a reasonable balance between these two issues: reducing cost versus improving customer service.

If we analyze the key logistics decisions that are relevant in obtaining optimal performances the following issues are identified (Van der Vorst et al., 2002; Soysal et al, 2012). In terms of network design, crucial issues are: the roles and the types of operations performed in facilities, locations of facilities, capacities allocated to each facility, markets that facilities will serve and sources that will feed facilities (Chopra and Meindl, 2010). Additional generic issues identified are: (i) distribution channel choice among several distribution options, (ii) outsourcing possibility, (iii) operations excellence with respect to time, quantity and invoice, (iv) strategic inventory positions choice, (v) transportation alternatives and constraints (e.g. time windows, number of vehicles, capacity of carriers), (vi) production choices (e.g. workforce scheduling, multiple product handling, batch size consideration), (vii) incorporation of supply and demand uncertainty and (viii) use of information technologies (e.g. Geographic Information System or Wireless Sensor Network).
Table 2: Key logistics objectives in sustainable agro-logistics management (Soysal et al., 2012)

<table>
<thead>
<tr>
<th>Key aims</th>
<th>Drivers &amp; Enablers</th>
<th>Explanation</th>
<th>Key logistics issues</th>
<th>Literature</th>
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<tbody>
<tr>
<td><strong>Logistics Management</strong></td>
<td>Economic crisis resulting in low prices</td>
<td>The ability to minimize total global network costs from the source of supply to its final point of consumption.</td>
<td>Network design, Distribution channel choice, Outsourcing, Operational excellence, Inventory positions choice, Transportation alternatives and constraints, Production choices, Incorporation of uncertainty, Use of information technology.</td>
<td>Beamon, 1998; Cachon and Fisher, 2000; Christopher and Juttner, 2000; Chopra, 2003; Chopra and Meindl, 2010; Fisher, 1997; Gunasekaran et al., 2008; Lambert and Cooper, 2000; Simchi-Levi et al., 2009</td>
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<td></td>
<td>Globalisation resulting in world-wide competition</td>
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<td>Automation resulting in more efficient processes</td>
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<td><strong>Logistics Management</strong></td>
<td>Demand for more product variety, high frequent deliveries with short lead times and small batches</td>
<td>The ability to have a flexible and robust system that satisfies customer orders in time and responds quickly to the dynamics of the global marketplace. Additionally, to cooperate and collaborate with the other supply chain members in a way that facilitates movement of information in timely, reliable and accurate manner.</td>
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<td>Increased demand uncertainty</td>
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<td></td>
<td>New ICT tools that facilitate more advanced information exchange</td>
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<td><strong>Agro-Logistics Management</strong></td>
<td>Demand for safe and high quality food products</td>
<td>The ability to control product quality in the supply chain and deliver high quality food products in various forms to final consumers by incorporating product quality information in logistics decision making.</td>
<td>All the above + Homogeneity controls, Dynamic inventory management, Dynamic control of goods flow, Cold chain management, Multiple temperature consideration for multiple products, Product interferences consideration, Monitoring temperature history, Customer requirements consideration, Use of specific quality decay models, Waste management.</td>
<td>Akkerman et al., 2010; Blackburn and Scudder, 2009; Dabene et al., 2008; Hafulabason et al., 2012; Tienekens and Zuurbier, 2008; Van der Vorst et al., 2000, 2002, 2007, 2011; Van Donselaar et al., 2006</td>
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<td></td>
<td>Health consciousness of consumers</td>
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<td>Year round availability of food</td>
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<td>Demand for more convenience products</td>
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<td>Technological improvements</td>
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<td><strong>Agro-Logistics Management</strong></td>
<td>Demand for high quality products with long shelf lives</td>
<td>The ability to collaborate in the supply chain network to reduce food that is discarded or lost uneaten because the quality has deteriorated.</td>
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<td>Increased food security concerns</td>
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<td>Pressure from global organizations</td>
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<td><strong>Sustainable Agro-Logistics Management</strong></td>
<td>Growth of world population Climate change</td>
<td>The ability to reduce environmental impacts (e.g. GHG emission, energy use, water use, air pollution, deforested land, land availability and noise) of operations and to facilitate new energy sources such as biofuels.</td>
<td>All the above + Use of impact assessment tools, Sustainable food production consideration, Sustainable inventory management consideration, Sustainable transportation management consideration, Traceability possibility of products.</td>
<td>Bettley and Burnley, 2008b; Chaabane et al., 2012; Dekker et al., 2012; Fritz and Schiefer, 2009; Helms, 2004; Linton et al., 2007; Nepstad et al., 2010; Wang et al., 2011; Wognum et al., 2011</td>
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<td></td>
<td>Limited natural resources Escalating sustainability awareness</td>
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<td><strong>Sustainable Agro-Logistics Management</strong></td>
<td>Increased child labour Employment Escalating sustainability awareness</td>
<td>The ability to reduce societal impacts (e.g. nutritional content of products, employment opportunities, farm income) of operations.</td>
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<td>Recent food crises Legislation</td>
<td>The ability to have complete visibility of all relevant product and process characteristics in the chain allowing to track and trace products throughout all stages in a supply chain.</td>
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2.2. Improved food quality and reduction of food waste

Nowadays, consumers ask for safe and high quality products with a competitive price throughout the year (Apaiah and Hendrix, 2005; Trienekens and Zuurbier, 2008). In food supply chains (FSCs), the quality of the product continuously changes starting from the time the raw material leaves the grower (or the slaughter for meat products) to the time the product reaches the consumer (Dabbene et al., 2008). This quality change (often degradation) necessitates keeping track of and preserving perishable product quality along the FSC to increase its freshness. These changes in product value make conventional SC strategies, not taking perishability into account, inappropriate (Blackburn and Scudder, 2009). Perishable products require management approaches and models that can cope with additional challenges such as temperature controls, quality decay or waste reduction methods (Haflidason et al., 2012; Van Donselaar et al., 2006). Technological improvements (e.g. temperature controlled facilities and trucks) enable FSCs to manage food quality throughout the chain. Van der Vorst et al. (2011; 2007) propose the concept of Quality Controlled Logistics (QCL) and claim that the establishment of better FSC designs depends on the availability of real time product quality information and the use of that information in advanced logistics decision making along the chain. Apart from this work, also other studies in literature are devoted to the special planning of perishable food products (Adachi et al., 1999; Entrup et al., 2005; Tarantilis and Kiranoudis, 2001). Additionally, consumers have started to desire more convenient products that require minimal preparation such as ready to eat or just heating before eating.

Related to food quality is the concept of food waste, dealing with preventing or reducing food spoilage in the supply chain. It is estimated that in developed markets about 40% of food is wasted, predominantly at the consumer end in the supply chain. Industrialized and developing countries dissipate roughly the same quantities of food. Low income countries show relatively large food losses in the early stages of the chain, with decreasing wastage levels in consecutive stages (see figure 1 and 2).

Research shows (see figure 1) that giving exact figures regarding food losses is hard. But the figures also show that food losses are relatively the same in both developing / Low Income Countries (LIC) and developed countries. FAO (2013) reports and WRI analyses (Lipinski et al, 2013) states that about 56 percent of total food loss and waste occurs in the developed world—North America, Oceania, Europe, and the industrialized Asian naTons of China, Japan, and South Korea—whereas the developing world accounts for 44 percent of the loss. In the developing countries and LIC food losses are predominant in the beginning of the food chain; handling and storage after harvest show the biggest food losses. As a result, improving the food supply chain in developing countries / LIC has to focus on improvement of farm practices and post-harvest logistics.
Figure 1. Overview of food losses by region and supply chain stage (Lipinski et al., 2013) Page 9
Next to the key logistics issues for the traditional indicators, there are some additional issues that need to be taken into account to improve food quality and reduce food waste (Soysal et al., 2013). These are:

(i) batch homogeneity controls along the chain, (ii) dynamic inventory management that tracks the quality of products, (iii) dynamic control of goods flow that adopts conditions and logistics to optimize market fulfilment (e.g. redirecting products to other markets having lower quality requirements), (iv) cold chain management that considers temperature or enthalpy controlled carriers and depots, (v) multiple temperature consideration for multiple products, (vi) product interferences consideration for specific markets, (vii) monitoring temperature history for accurate quality predictions, (viii) customer requirements consideration for specific markets, (ix) use of specific quality decay models in logistics decision routines, and (x) waste management practices that considers food spoilages.

2.3. Improved sustainability and traceability

Consciousness of consumers towards environmental and societal issues put pressure on companies to use sustainable practices, since world population is growing, climates are changing and natural resources are depleting. Also, nutritional content of products (Helms, 2004), increased child labor and employment conditions are under discussion as societal issues. Seuring and Muller (2008) summarize the pressures and incentives for sustainability in supply chains as follows: legislations, customer demands, response to stakeholders, competitive advantage, pressure groups and reputation loss. As a consequence, increasing sustainability awareness of stakeholders (Bettley and Burnley, 2008a) inevitably affects the (logistics) decision making process and operations in FSCs. As such, the concept of sustainable SC design has emerged and aims to incorporate economic, environmental as well as societal decisions into SCs in the design phase (Chaabane et al., 2012; Wang et al., 2011). However, it is obvious that the environmental and social dimensions of SFSCM must be undertaken with a clear and explicit recognition of the economic goals of the firm (Carter and Rogers, 2008; Wognum et al., 2011).

Due to globalization and recent food scandals, consumers also want to get more insight in production processes as well as what happened to the product as it moves through the SC (Mogensen et al., 2009). This places emphasis on especially the people and planet aspects of sustainability. Legislations from governments or pressures from non-profit organizations aim to stimulate improved SC visibility in FSCs. A good traceability system can contribute to improved transparency by offering specific information regarding product and related processes to consumers (Fritz and Schiefer, 2009; Wognum et al., 2011). Additionally, Fritz and Schiefer (2008) stress the importance of intensified cooperation and collaboration between the actors of the chain and improved monitoring of activities to achieve transparency and tracking and tracing of products and services throughout the value chain. This integration and monitoring can be enhanced with the use of new ICT tools to redirect the pattern of logistics operations.

Next to the key logistics issues for the traditional and food quality related indicators, there are some additional logistics issues that need to be taken into account to improve sustainability and traceability (Soysal et al., 2013). These are: (i) use of impact assessment tools (e.g. Life Cycle Assessment Analysis (LCA) assesses impacts of operations associated with all stages of a product's life starting from cradle-to-grave), (ii) sustainable food production consideration (e.g. using efficient machines that can reduce water use consumption or choosing production locations considering deforestation, land use issues,
closed loop systems), (iii) sustainable inventory management consideration (e.g. controlling energy use of cooling stocks in facilities (Akkerman et al., 2010)), (iv) sustainable food transportation management consideration (e.g. considering GHG emissions, fuel consumptions of different transportation modes, new energy sources such as biofuels or noise, air pollution caused by vehicles (Dekker et al., 2012)), and (iv) traceability possibility of products for improving transparency in FSCs (e.g. use of safety focused traceability systems).

4. Global agro-logistics: case examples and key bottlenecks

In order to illustrate the impact of the trends and developments on the agro-logistics system of different global regions, this section presents a number of projects run by Wageningen University and Research Center in India, China, and the Filipines, Ethiopia, Ghana, Mexico, and Thailand. It is not intended to provide a complete overview of current developments, but rather to illustrate what is happening on agro-logistics in the different regions. Subsequently, an overview will be presented of what literature has indicated as key bottlenecks for agro-logistics in developing countries.

Example 1. Metropolitan Food Clusters in India, China, Filipines.

<table>
<thead>
<tr>
<th>Country</th>
<th>India, China, Filipines</th>
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<tbody>
<tr>
<td>Issues in 2013</td>
<td>The world is urbanizing. In 2050 75% of the predicted 9 billion people will live in cities. The growth of the urban middle class with increasing purchasing power revolutionises food consumption in quality and quantity. The reverse of this process is the marginalisation of rural areas through depopulation, ageing and brain drain. Still they are largely responsible for world food production. A radical innovation of the system and an increase in sustainable agricultural productivity is necessary.</td>
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<tr>
<td>Agrologistics needs</td>
<td>The system innovation of Metropolitan Food Clusters (MFC) meets these challenges by aiming at vertical and horizontal integration of value chains. Components of the MFC-network are, at one end of the chain, production regions with Rural Transformation Centres that shift to sustainable production and precision agriculture. At the other end well developed agro logistics with Distribution and Consolidation Centres which are directly serving metropolitan and export markets. Agroparks form the linking pin and motor between the two. Agroparks are spatial clusters of several value chains in an industrial set up, situated close to the metropolis. They contain a variety of land independent production, processing, agrologistic and support functions. Between them principles of industrial ecology are being applied.</td>
</tr>
<tr>
<td>Interventions (performed or detected)</td>
<td>The MFC concept is aiming at sustainable development. It develops through a 'creative research by design' process (co-design), in which Knowledge Institutes, Entrepreneurs, Non-Governmental and Governmental Organisations co-operate. Co-design focusses on the 'hardware' of the MFC as well as on the more complicated 'orgware' aspects (co-operation structure, business development) and on time consuming 'software aspects' (education and training, communication).</td>
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</tbody>
</table>
Example 2. Exporting fruits and vegetables from Ethiopia.

<table>
<thead>
<tr>
<th>Country</th>
<th>Ethiopia</th>
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</thead>
<tbody>
<tr>
<td>Issues in 2012</td>
<td>Ethiopia’s current fruits and vegetables (F&amp;V) production is low, but the country has potential to increase producing and exporting a wide range of products throughout the year. Demand for fruits and vegetables is growing in nearby international markets, like the Middle East. Although Ethiopia is land locked, it is geographically close to the Middle East. To reach the Middle East, and other international markets, produce has to be transported to Djibouti where it can be shipped. Roads to Djibouti are generally good, but transportation takes long due to waiting times at the border, sometimes up to ten hours. Fresh produce is sensitive and needs to be refrigerated to remain fresh and of good quality during such long transportation time. To start exporting to the Middle East it is of paramount importance to build a good reputation and to deliver the F&amp;V in good condition. Refrigerated container transport offers possibilities to make use of the potential to export more F&amp;V in good quality.</td>
</tr>
<tr>
<td>Agrologistics needs</td>
<td>Fresh fruit and vegetables (F&amp;V) are perishable and have a relative short shelf life. Therefore, especially for F&amp;V, costs of transportation are a crucial factor determining the competitive position in export markets. Several entrepreneurs have done trials with exporting common F&amp;V by air to the Middle East, but not successfully. Airfreight is only an option for high-value products. The development of a refrigerated cool chain for relatively nearby markets such as the Middle East could dramatically improve the competitive position of Ethiopia.</td>
</tr>
<tr>
<td>Interventions (performed or detected)</td>
<td>Sea transportation is becoming more and more interesting due to the decreasing capacity in air transportation and much lower environmental impact (and possibly costs). It is required to have good quality to be able to enter the export market and to compete with other exporting countries. Reefer containers will ensure maintenance of quality during transportation. The quality of the produce should be high from the very start. It is therefore recommended to carefully select the seed or seedlings and have proper production and post-harvest technologies. Exporting F&amp;V from Ethiopia to the Middle East and in particular to Saudi Arabia and the UAE over sea by using reefers is practically feasible. For sea transportation it is important that the produce is continuously in the optimal environment. Fortunately, a closed cold chain is feasible – the container does not have to be reopened during transportation. However, the reefers are currently not available in the country but can be imported, including the required gensets. However, the costs of importing the reefers are high, resulting in relatively high costs to get the fruits and vegetables cool in the port in Djibouti. In order to make full use of a container you need to be able to load it completely. Therefore the reefers are yet a feasible option for large scale producers, but not yet for small scale producers who would need a fresh consolidation center. It is recommended to organize such centers who can receive F&amp;V from different farmers, offer cold storage possibilities and fill a container efficiently. The economic feasibility of using reefers for exporting fruits and vegetables depends very much on the type of produce and the negotiated market price. In any case it will be more positive for F&amp;V, which can be packed efficiently and therefore fill a container with a higher tonnage. The market price is always based on a weight basis, and as most container transportation costs are based on a volume basis it is profitable to have a high weight in one container. The activity lead time is a maximum of 18 to 22 days, excluding the desired shelf life of 7 days in the shop and/or at consumers’ home. This slightly long transportation time is a bottleneck for reefer transport to the Middle East. This is due to the fact that ships from Djibouti will first have to go to Salalah before continuing. Djibouti is enlarging its port and if sea transporters are willing to change their routes, transportation times will be shorter.</td>
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</table>
Example 3. Reduction of post-harvest losses in Ghana.

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<thead>
<tr>
<th>Country</th>
<th>Ghana</th>
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<tbody>
<tr>
<td>Issues in 2013</td>
<td>For Ghana applies what can be learned from an analytical review of post-harvest losses (PHL) in Africa (IDRC/CRDI 2013), namely:</td>
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<td></td>
<td>• Many innovations to reduce PHL are known and available in literature. Various socio-economic factors hinder the promotion of the technologies into the real world;</td>
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<td></td>
<td>• Data on cost of PHL reduction and economic benefits are lacking. Most innovations are transferred without a clear economic outlook when adopted;</td>
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<td></td>
<td>• Many innovations are launched and after a relative short time abandoned due to lack of organised structures of farmer groups and or SME’s who have already an agribusiness concept in place. Technology adoption needs these progressive groups with a minimum of economy of scale. These stronger groups will encourage less progressive parties in value chains to embrace the innovations as well;</td>
</tr>
<tr>
<td></td>
<td>• PHL innovations need a holistic approach (link farm activities to off-farm practices: processing, storage, packing, transport). Other factors are: no national policies, poor infrastructures, poor marketing systems, lack of knowledge and knowledge capacities.</td>
</tr>
<tr>
<td>The main challenge is how to reduce PHL making use of available knowledge and innovations.</td>
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</table>

Agrologistics needs

Interventions to minimize PHL are more successful when the stakeholders start up commodity oriented projects within the framework of cooperatives, platforms or networks. A good example is the cashew and shea nut network in Ghana, where education, ICT and microfinance improved the livelihood of local farmers and woman. See: [http://youtu.be/k32D7UrgkCw](http://youtu.be/k32D7UrgkCw); [http://youtu.be/pWkuaPdXUB0](http://youtu.be/pWkuaPdXUB0). From a cash crop perspective a good example of a value chain approach is the processing of pineapples in Ghana into fresh fruit salads for the UK market (Blue Skies inc.). However after almost a decade of successful business affairs the company now suffers from inadequate sourcing (many farmers went down due to price volatility).

Interventions (performed or detected)

To have real impact on PHL a national agro-logistic strategy based upon three pillars is a necessity. First, efficient vertical value chains aim to coordinate the interventions to be implemented by many stakeholders. This means the integration of hardware (technology), orgware (organisational, institutional, financial and procedural aspects) and software (skills, knowledge, communication, intercultural). Second, it demands an efficient logistics network that focusses on the increase of transport of agro products and food products because of growing distances between primary producers and consumers and increasing diversity of products for urban consumers. The last step will be the horizontal integration between chains.
Example 4. A vision on Agro-Logistics for Mexico.

<table>
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<tr>
<th>Country</th>
<th>Mexico</th>
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</table>
| Issues in 2013 | A key question for the government is: How should the Mexican Ministry of Agriculture and other government agencies act regarding land-use planning and efficient use of human and environmental resources in the Agro-logistics sector. Key is to arrive at a domestic policy agenda on the following topics:  
• Food security  
• Improvement in labour conditions and migration in rural areas  
• Bring the Mexican agrifood sector to par with international quality and phytosanitary standards  
• Position Mexico as an agrifood power, competitive in international markets |
| Agrologistics needs | In 2014 the project lead by WUR will develop and explicate a Vision Agro-logistics, intended to mobilize Mexico’s agrifood sector towards the development of a new nationwide Agro-logistics network. This network must include modern (refrigerated) infrastructures, as well as a dynamic private sector and specialized human capital in Agro-logistics services of the highest quality. |
| Interventions (performed or detected) | Three interventions have been identified that will be further elaborated upon in 2014:  
• Intervention 1. Infrastructure development: Infrastructure planning (cold chains) and logistics intelligence (cost analysis models, information systems, traceability, etc.);  
• Intervention 2. Institutional development: Strategic planning to obtain greater budgetary efficiency and acting capability of institutions, as well as alignment and association of key stakeholders from four main areas: government, business, knowledge and civil society (also known as KENGi);  
• Intervention 3. Knowledge development and transfer: Design of new educational programs and resource planning for training, and organization of stakeholders also from four main areas: government, business, knowledge and civil society. |
Example 5. Exporting exotic fruits from Thailand.

<table>
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<tr>
<th>Country</th>
<th>Thailand</th>
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<tbody>
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<td>Issues in 2010</td>
<td>Thailand encounters the following challenges: spread of plant diseases leading to pre-harvest loss of 30-40%, chemical residues; 2% of produce affected, outdated post-harvest applications and handling practices leading to PHL of 25%, high airfreight costs, limited logistics innovations, unaligned standards and certification schemes; hard to get access to EU market. The question for Thailand was how to enhance international supply chains of exotic fruits knowing that bottlenecks in the Thai agro logistics have a negative influence on the productivity and income of the agricultural sector.</td>
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</table>
| Agrologistics needs | The following bottlenecks for exporting Thai products to European markets are distinguished:  
- Poor product handling: Thai farmers are handling fruits not efficiently, use inappropriate and unclean machineries, rely on prohibited chemical fertilizers and implement improper post-harvest methods. Consequence: diseases occur on the fruits.  
- Chemical residues: Thai farmers are still relying on EU prohibited chemical fertilizer and pesticides.  
- Broken cold chains: Unconditioned transport of fruits from farm to packing station. Cold stores facilities at Bangkok airport are modern and clean. Temperate settings are not always sufficient however.  
- Inconsistent certification scheme: Mostly, Thai products are not in line with required quality standards from the European market (like GlobalGAP).  
- Outdated packaging: due to lack of finance to implement modern packaging techniques, packaging concepts are of limited quality (i.e. ventilation, strength, weight, used materials, etcetera) and lack information that European importers demand. Not only in relation to GlobalGAP but also customer demands and European law.  
- Inefficient loading at airfreight capacities and high airfreight cost: There is inefficient loading at the airfreight. Airfreight costs are relatively high in Thailand in comparison to their neighbouring countries due to lack of cargo space and high costs of using Thai airspace (e.g. mango to EU costs are € 2.40 (114 Baht) per kilogram). |
| Interventions (performed or detected) | Postharvest concepts; Container at the farm or packing center (depending farm accessibility), stuffing container with precooled products or hot, ‘ready to pick’ principle at the farm to improve product quality upon arrival, ‘specific packaging’ at the farm to decrease value and/or quality loss (depending on the learning abilities of the farm).  
Export concepts;  
- Sea-air bridge: sailing the goods to United Arab Emirates or Singapore, re-packing the goods and then flying the goods to The Netherlands. This decreases transportation costs and duration.  
- Air-sea bridge: flying the goods to Singapore, re-packing the goods and then sailing the goods to The Netherlands. This decreases transportation costs and duration.  
- Air triangle: charter a plane and transport goods from Thailand to EU and to return via for example to the United Arab Emirates (assuming that there is a demand for exporting goods from The Netherlands to for example to the United Arab Emirates).  
Macro economic concept. develop towards a regional market place or hub where products not only from Thailand but also from regional producers are brought to and where (potential) buyers are also present. The hub potentially supports the development of more efficiency along the value chains of the various produce at offer as well as an improved functioning of the markets. In addition, bringing both suppliers and buyers physically together at one place potentially has a positive impact on the overall product quality over time. (In analogy to the positive influence that the Dutch flower auctions had and are still having on the level of the overall product quality of the flowers.) |
The examples given above illustrate that each region has its own specific issues and needs. In literature many reports and papers can be found that discuss such case-specific findings. Van Gogh et al. (2013) conducted a dedicated extended review of literature and projects (140 references with reference years 2000-2012) focusing on post-harvest losses of fruits & vegetables in developing countries. This review concluded with a top 10 of main categories of causes for postharvest food losses in developing countries given in Figure 2. They conclude that improving the post-harvest supply chain in developing countries/LIC one first has to focus on cold chain management and climate controlled transport. The next major enablers are improved storage facilities followed by better product handling and packaging.

![Figure 2. Top 10 causes of postharvest losses mentioned by 140 literature references (Van Gogh et al., 2013).](image)

Other scientific literature takes a broader perspective on logistics issues in international trade. For example, Devlin and Yee (2005) analysed obstacles facing exporting firms in developing countries by diagnosing the efficiency of trade logistics in the Middle East and North Africa region. Using logistics chain analysis for six export commodities, they present evidence that transport and non-transport logistics costs for export commodities from the MNA region are quite substantial, ranging from 7-25 per cent of landed product prices. Underlying these costs are key bottlenecks identified as: inefficient
trucking and transport services, low export volume leading to long shipping times and the need for costly inventory accumulation, aggressive, obstructive customs authorities and procedures, low and inconsistent product quality, an underdeveloped transport intermediary sector, inefficient cross-border transit procedures and others. They conclude with a number of recommended actions foremost in the policy and legal domain, such as developing a national transport policy, overhauling the regulatory regime for the trucking sector, export promotion measures, increasing competition in port and air freight services, reorienting customs authorities towards trade facilitation and developing cross-border transit procedures. It is clear that next to core logistics decisions related to infrastructure, capacities and logistics management, also the environment within which the logistics processes take place (foremost policy and regulations) are key to improved performances.

Overlooking all cases and relevant literature (for example, Tonelli et al. 2012; Van Gogh et al., 2013) the following bottlenecks become apparent (this list is not intended to be complete):

- Inadequate technology & infrastructures:
  - Inadequate road infrastructures; unpaved or highly degraded roads limit transit
  - Transport is irregular and slow –often covering long distances
  - Inadequate storage systems and processing equipment
  - Limited transport means; lack of cold chain capacities (trucks, warehouses, etc.)
  - Lack of appropriate packaging materials
  - Inadequate information and communication systems
- Lack of effective food logistics management systems
  - Transport costs are high and have a significant impact on profits
  - Lack of practices to manage variability in availability and quality of raw materials
  - Lack of adequate quality management systems and practices
  - Lack of market information; chain transparency
  - Lack of effective logistics planning practices
  - Lack of collaborative efforts to improve supply chain logistics
- Lack of relevant knowledge and skills of personnel
- Lack of access to financial means
- Insufficient government support
  - Complex trade regulations
  - Long waiting times to cross borders; administration, policy and tax issues
  - Lack of and high prices of fuels, water and energy

4. Potential interventions to address the needs

It is clear that agricultural supply chains have lots of bottlenecks but also opportunities for improvement and innovation, as sustainable efficient supply chains contribute to safer food, to more competitive sourcing in developing countries, and to less waste of food. Efficient food supply chains are also the main hope of diversification and enhanced export opportunities of a number of the poorest economies,
notably in Africa. When products of high quality can be produced and delivered to international markets, higher prices can be obtained. Foreign investments already increased the technological standards as well education levels in developing countries giving space to further economic developments and increase of food security. It is clear that progress can only be made if local governments support such developments, do not create trade barriers and co-invest with businesses in road and communication networks.

It is clear that improving quality management, i.e. improving product quality, improving post-harvest handling will lead to less food losses, higher yield, higher turnover and even higher margins. But also the design of effective cold chains which requires the constant and reliable availability of power. Innovative solutions as solar energy are an option. However, this must be 'proven technologies' tuned to the conditions in the respective countries. Processing (for example drying) could be an option for products to lengthen shelf life and being able to simplify the food chain. But also many other interventions are mentioned, such as clustering and consolidating production in agroparks, homogenize and/or segregate between quality levels, adapt packaging to product and chain and invest in good packaging, use a value chain approach: convenient, special packed, minimal processed, etc., meet international standards: certify for GlobalGap, BRC etc., create awareness and knowledge, combine R&D, pack house activities and education in regional post-harvest centers.

An extended literature review of Macheka et al. (2014) inventorised effective interventions for reduction of post-harvest losses. We categorized these and the earlier mentioned interventions to into one framework to provide an overall overview of interventions to improve agro-logistics in developing countries – see table 3.

5. Conclusion and recommendations

This position paper discussed the state of the art concerning agro-logistics in developing countries. We defined agro-logistics, discussed megatrends and developments, identified bottlenecks in agro-logistics using literature and five illustrative cases, and defined a list of potential interventions to improve performance on cost, quality and sustainability indicators. We end this paper with a number of recommendations that can help tackle the logistics challenges in agri-logistics.

Recommendation 1. Improve the logistics infrastructure.

It is clear that improvements of road networks next to appropriate vehicles will improve logistics performances. Furthermore, investments should take place in generators, water reservoirs, storage systems, cold chain facilities, and the establishment of cold storages in the vicinity of production. Advanced and appropriate ICT systems (especially for large scale firms) will stimulate advanced logistics practices, and enhance the capacity of the small and medium agri-food firms to utilize ICT systems to support their logistics performance.
Table 3. Overview of possible interventions for improved Agro-Logistics in developing countries.

<table>
<thead>
<tr>
<th>Chain aspect</th>
<th>Logistics objectives</th>
<th>Technology</th>
<th>Infrastructure</th>
<th>Logistics management</th>
<th>People</th>
<th>Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost - responsiveness</td>
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<td></td>
<td>Quality – food waste</td>
<td>Use of genotypes that have longer post-harvest life</td>
<td>Use of protective (modified atmosphere) packaging to maintain quality and safety</td>
<td>Use of modified atmosphere to retard fungal growth</td>
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<td></td>
<td>Sustainability - transparency</td>
<td>Create more market transparency</td>
<td>Use more sustainable vehicles</td>
<td>Use tags and sensors to monitor goods flows</td>
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<tr>
<td>Technology</td>
<td>Improving processing techniques to increase capacity</td>
<td>Improve processing techniques to increase capacity</td>
<td>Invest in new storage systems and processing equipment</td>
<td>Invest in information and communication systems</td>
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<td></td>
<td></td>
<td>Improve cold chain management facilities at ports</td>
<td>Improve sanitary and phytosanitary review and inspection processes</td>
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<tr>
<td>Infrastructure</td>
<td>Improve road infrastructures</td>
<td>Meet criteria of international standards: certify for GlobalGap, BRC etc.,</td>
<td>Introduce clustering and consolidating production in agroparks,</td>
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<td></td>
<td>Improve cold chain management</td>
<td>Improve cold chain management facilities at ports</td>
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<td></td>
<td></td>
<td>Use of modified atmosphere to retard fungal growth</td>
<td>Improve sanitary and phytosanitary review and inspection processes</td>
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<tr>
<td>Logistics management</td>
<td>Support collaborative efforts to improve supply chain logistics</td>
<td>Use integrated crop management systems and Good Agricultural Practices</td>
<td>Introduce clustering and consolidating production in agroparks,</td>
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<td></td>
<td></td>
<td>Use proper post-harvest handling practices in order to maintain product quality</td>
<td>Use of modified atmosphere to retard fungal growth</td>
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<td></td>
<td>Improve procedures for minimizing mechanical damage</td>
<td>Improve cold chain management</td>
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<td>Cold chain management</td>
<td>Improve cold chain management</td>
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<td></td>
<td>Monitoring temperature history</td>
<td>Improve cold chain management</td>
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<td></td>
<td></td>
<td>Multiple temperature consideration for multiple products,</td>
<td>Improve cold chain management</td>
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<td></td>
<td></td>
<td>Use quality decay models to predict quality changes</td>
<td>Improve cold chain management</td>
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<tr>
<td>People</td>
<td>Educate personnel</td>
<td>Create awareness and knowledge,</td>
<td>Create awareness and knowledge,</td>
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<td></td>
<td></td>
<td>Develop knowledge and capacity of operators to apply good handling practices</td>
<td>Develop knowledge and capacity of operators to apply good handling practices</td>
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<td></td>
<td></td>
<td>Training for packers on how to select appropriate fresh produce</td>
<td>Training for packers on how to select appropriate fresh produce</td>
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<td>Effective training of workers and their supervisors along with delegation of responsibility and authority</td>
<td>Effective training of workers and their supervisors along with delegation of responsibility and authority</td>
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<tr>
<td>Policy</td>
<td>Combine R&amp;D, pack house activities and education in regional post-harvest centers.</td>
<td>Reduce waiting times to cross borders; administration, policy and tax issues</td>
<td>Reduce waiting times to cross borders; administration, policy and tax issues</td>
<td>Reduce waiting times to cross borders; administration, policy and tax issues</td>
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<td>Establish of suitable market institutions</td>
<td>Establish of suitable market institutions</td>
<td>Establish of suitable market institutions</td>
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<td>Develop markets for ‘sub-standard’ products to avoid throwing away of products</td>
<td>Develop markets for ‘sub-standard’ products to avoid throwing away of products</td>
<td>Develop markets for ‘sub-standard’ products to avoid throwing away of products</td>
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<td></td>
<td></td>
<td>Public sector should invest more in infrastructure, transportation, and processing</td>
<td>Public sector should invest more in infrastructure, transportation, and processing</td>
<td>Public sector should invest more in infrastructure, transportation, and processing</td>
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<td>Implementing legislation to prevent and reduce food wastage</td>
<td>Implementing legislation to prevent and reduce food wastage</td>
<td>Implementing legislation to prevent and reduce food wastage</td>
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<td></td>
<td></td>
<td>Regulations covering proper handling procedures and food safety issues</td>
<td>Regulations covering proper handling procedures and food safety issues</td>
<td>Regulations covering proper handling procedures and food safety issues</td>
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<td>Establishing national sanitary and phyto-sanitary standards to facilitate access to international market.</td>
<td>Establishing national sanitary and phyto-sanitary standards to facilitate access to international market.</td>
<td>Establishing national sanitary and phyto-sanitary standards to facilitate access to international market.</td>
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</tbody>
</table>
Recommendation 2. Improve quality management practices

It is of utmost importance that product quality and safety becomes leading, hence, quality assurance systems along with traceability systems are required to monitor and control goods flows. Actors and employees in the chain should be educated and trained to handle the product in the best way.

Recommendation 3. Accelerate and support collaborative initiatives and increase investments to reduce postharvest losses

Maintaining quality in the chain and reducing food losses requires actions from all stages in the supply chain – from households, farmers, logistics companies to policy makers. It also requires changes in technology, processes and behavior. For each country, the most relevant and promising techniques and practices should be identified and implemented. Food loss and waste measurement protocols should be developed in collaboration with FAO and organizations such as WRAP in the UK. Collaborative initiatives can facilitate sharing and transferring of best practices and help to build capacity for all actors. This collaboration refers to the primary actors in the chain as well as with research and financial institutions. Also, knowledge on post-harvest losses reduction should be transferred to education centers (see Lipinski et al. (2013) and figure 3 for a more extended view on this recommendation).

Figure 3. Possible approaches for reducing food loss and waste (Lipinski et al., 2013).
Recommendation 4. Encourage political willingness and good governance

The most important external bottleneck faced in agro-logistics relates to tax issues, trade barriers, phytosanitary and inspection regulations, etc. If local governments can allocate appropriate budget for logistics and install working practices that facilitate the elimination of regulations, resulting in fast throughputs of goods in ports and over country border lines, product quality as well as costs can be maintained within required performance boundaries. If also investments are done in alternative power supply schemes such as solar energy, wind energy etc. this might also decrease refrigerated transport and processing costs and stimulate cold chain management practices. Such policies will also bring along foreign investors to upgrade the logistics infrastructure and knowledge network.

Governments in emerging and developing markets want to improve their national food system but do not have a strategic plan how to get there. There are many scattered initiatives that hardly contribute to a national improvement in food security and are difficult to be multiplied. Sometimes there are plans on a very high national level, but these hardly connect to regional or local initiatives. The development of a national vision on agro-logistics and food security with concepts & tools that can be extended and connected to lower level regional plans will further enhance performances.

Recommendation 5. Conduct extended case studies

Every country has its own dynamics and every product type (dairy, meat, fruits, coffee, grain etc.) has its own specific characteristics. It is advised to conduct dedicated studies on agri-food logistics covering wider regions and multiple product types and analyze specifically what contextual factors influences best practices. This work should be conducted in collaboration with logistics operators and customs agents that have representative data on transport costs and times within the region. A series of supply chain analyses at country level that compare results for well-developed supply chains and potential growth exports can help in diagnosing each countries particular weaknesses. In each case the research team has to go through series of key questions that will need to be answered. Examples of key questions are given below.

<table>
<thead>
<tr>
<th>Key question</th>
<th>How could the key question be answered?</th>
</tr>
</thead>
</table>
| What is the present situation of the agro-logistics sector identified by data analysis and expert views? | □ Literature review  
□ Report on global agrologistics best practices prepared by international experts  
□ Diagnosis Report                                      |
| What are the present agrologistics costs compared to international standards?                            | □ Literature review  
□ Policy summary matrices prepared by research centers  
□ Interviews with key stakeholders                        |
| How to increase the quality of agrologistics services in the concerning country/region, in order to add value to the product chains? | □ Analysis of conditions in concerning country/region including the identification of opportunity areas where value can be added through interviews and local specialist analysis  
□ Definition of quality goals  
□ Identification of key policies                         |
References


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